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INFORMATION SYSTEMS: HOW THEY
AFFECT AND ARE AFFECTED BY
ORGANIZATION STRUCTURE

by

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Information Systems: How They
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ABSTRACT

This thesis identifies the impacts of organizational structure on the implementation/operation of management information systems, as well as the impact of information technology upon organizational structure.

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I. INTRODUCTION

A. FIVE BASIC PARTS OF AN ORGANIZATION

Mintzberg's (1983) approach to organization design focuses on five basic elements; they are strategic apex, middle line, operating core, technostructure, and support staff.

1. The *strategic apex* includes the board of directors, president, and executive committee of the board.

2. The *middle line* is consists of a hierarchy of middle managers including vice-presidents, plant managers, district sales managers, and production supervisors. They serve to transmit and translate information between the strategic apex and the operating core.

3. The *operating core* consists of the people who actually perform the work, such as assembly line workers and sales representatives.

4. As an organization grows, it increasingly looks to standardize its processes and employee skills. This falls into the domain of the *technostructure* and includes strategic planners, personnel training departments, and production schedulers.

5. Lastly, organizations have *support staff* units that provide specialized services, such as a mailroom or cafeteria, to the organization itself and have no direct impact on the organization's primary task objectives.

B. TYPES OF ORGANIZATIONS

Mintzberg identified environmental stability, complexity, market diversity, and hostility as major determinants of structure and described five types of organization structures.

Most organization structures can be classified as having one of these five structural configurations:

1. Simple Structure

This is an organization with no structure, found in small to middle size organizations in dynamically changing environments. There is little or no hierarchy or support staff and the strategic apex is the key point. Coordination is primarily through direct supervision by a manager (strategic apex) and control is highly centralized, with everyone reporting to that person. Most organizations, such as family owned businesses, start out with this type of organization.

2. Machine Bureaucracy

This type of structure was originally described by Max Weber (1921) and consists of mostly repetitive, mechanistic work that could accomplished using standardized work processes. Changes in the external environment are minimal and the product line is narrow. Assignments, rules and procedures, communication channels, and a hierarchy of authority are clearly defined to minimize uncertainty. Mass production technology is used since the objective is to maximize the efficiency of the production of the output product. The tasks performed by the operating core are simple and repetitive, and workers have little training or discretion. Even minor discrepancies or problems (exceptions), therefore, must be handled by front-line supervisors. There are typically many levels to the middle-line hierarchy and they serve to accommodate and crystalize the vertical information flow between the operating core and strategic apex, as well as act as a buffer/liaison between the techno-structure and the workers of the operating core. The

techno-structure is a key part of this organization as it strives to further standardize and coordinate the work process.

3. Professional Bureaucracy

These organizations consist of a highly trained operating core that is the key component and performs work that is standardized. The core workers use skills that are predictable and pre-determined, such as accounting firms and hospitals. The environment is both complex and stable. This organization is not highly centralized as is the machine bureaucracy. Here, the members of the operating core have a large degree of control over their work and operate independently of each other. Coordination is by profession wide standards of acceptable behavior.

4. Divisionalized Bureaucracy

This form is a structure superimposed upon another since each division has its own structure. The divisional bureaucracy is the structural relationship between the structural apex of an organization and the top of the middle line management that runs each division. This is typically a decentralized structure in that the divisions have operational autonomy. Divisions are created according to the market served and are then given control of the operating functions (production, sales, finance, and so forth) required to serve these markets.

Divisionalized structure works best in simple, stable environments, much as the machine bureaucracy, and is characteristic of larger, more mature organizations. General Electric is an example of such a structure.

This form can be further described as Form A or Form B. In Form A, each division is centralized from within, but enjoys considerable freedom relative to the entire organization, with only major organization-wide policies and decisions being centralized. A central headquarters uses formalized budgets and goals as a performance control system. This structure is common in organizations competing in several diverse markets. With a Form B organization, the divisions are tied together by a strong culture rather than performance control systems, such as Kaiser Permanente.

5. Adhocracy

This structure is used in rapidly changing environments that require a free flow of information. Tasks at the operating core are continually changing and there is little formal hierarchy (decentralized). Employees share a common purpose and goals that ensure an organization operates efficiently. In an adhocracy innovation is the key, since existing skills are not applied as standard solutions, they are the basis for creating new solutions. Mintzberg's matrix structure is an example of an adhocracy, grouping personnel functionally for administrative purposes and drawing from these groups to construct project groups.

C. ELEMENTS OF ORGANIZATIONAL STRUCTURE

1. Formalization

Formalization is the degree to which an organization uses rules, regulations, procedures, and written communications. Formalization reduces the number of situations

requiring special attention, thus reducing the flow of information over or increasing the capacity of, an organization's lines of communication. This reduction in the amount of communications required in turn enables an organization to address non-standard situations more rapidly over existing channels. Mintzberg (1979) lists the following ways to formalize organization behavior:

1. *Formalization by job.* First, the organization can formally specify the nature of the job, typically documenting it in a formal job description. In addition, the worker may also be told what specific steps to take in his or her work; for instance: First, turn on the press, then adjust the gears, then place the tube on the rack, and then cut the tube.

2. *Formalization by work flow.* On a broader scale, the organization can also formalize or specify the behavior expected by formalizing the work flow; in other words, specifying what specific work is to occur at each step of the process. For example, manufacturing facilities often use job-order tickets that specify in writing what work is to be performed at each work station as a particular order proceeds through the plant. As another example, orchestra musicians usually work from written arrangements that specify each of their roles in a given symphony.

3. *Formalization by rules.* Rules are probably the most familiar examples of formalization. At work, behavior is formalized with rules such as, "No smoking on the job," and "All male employees must wear their light blue or white dress shirts when dealing with the public."

4. *Formalization by structure* (Dessler, 1986). Finally, you can formalize organizational communications by specifying whom each employee can or cannot communicate with in the organizational chain of command.

Formalization reduces variability, coordinates effort, specifies minimum acceptable behavior, and provides fair treatment of employees. One drawback of this tool is that worker performance may actually decrease to the levels of the minimum acceptable behavior if it was above that level. Also, the standards and regulations may become the objectives workers try to achieve, and not the original goal. For example (Euske, 1984), in

the Navy, the command's retention rate is often used as a measure of a commanding officer's performance. One command began to screen sailors eligible for reenlistment to determine their intentions. If they had no plans for reenlistment, they were marked ineligible for reenlistment, which is usually done with subpar performers, in order to make the retention rate higher. This not only invalidates the utility of the measure for leadership performance, it also convoluted the true status of the retention rate, masking any possible retention problems that may require attention.

2. Hierarchy and Complexity

Hierarchy refers to the ranked levels of authority and reward power that exist in an organization and complexity is used to describe the managerial span of control that an organization possesses. These two attributes are closely related. Hierarchical authority is the principle mechanism for solving interdepartmental conflicts. An organization can be categorized as flat or tall depending on how many levels it has. A company with 64 line workers supervised by four managers who were, in turn, managed by a single plant manager, would be a flat organization with a span of control of 16 for middle managers. If the same workers were managed by 16 supervisors, who were, in turn, managed by four managers that answered to a plant manager, the organization would be tall with a span of control of only four. The optimal span of control for an organization varies widely depending on factors such as task routineness, employee professionalism, and technology. For example, Woodward (1965) found that supervisory spans varied widely and both unit (span = 23) and process (span = 13) had smaller supervisory spans than mass-production firms (span = 49).

3. Centralization versus Decentralization

Decentralizing is the delegating of authority to subordinates for most decisions while maintaining control of decisions about organization-wide matters. Rules and guidelines are developed to address what authority is given to the subordinates and assist them in making decisions. However, even in a decentralized environment control mechanisms are present to monitor subordinate performance.

In a centralized environment, most decisions are channeled up the chain of command to upper management and subordinates are allowed little discretion.

4. Size

For most of the studies reviewed here, the size of an organization is defined by the number of workers it employs. The size of an organization can also be measured vertically and horizontally. The vertical size is a measure of the range of the value chain that an organization's hierarchy spans, while horizontal integration is a measure of the number and corresponding shares of markets in which the organization sells its final goods and services (Gurbaxani and Whang, 1991).

5. Technology

Technology is the knowledge, tools, and techniques used to transform inputs into organizational outputs (Daft and Lengel, 1986). These include characteristics of the input materials used, the transformation process that is performed and the characteristics of the outputs produced. Woodward (1953) developed three classes of core technology by which organizations can be grouped:

- Unit and small batch production (craftsmen, lawyers, doctors)
- Large-batch and mass production (assembly line processes, auto manufacturing, fast food service)
- Continuous process production (chemical manufacturing, metals or electrical power).

Technology is related to structure by its need for work control procedures, the degree of which varies depending on task routineness, analyzability, and complexity.

II. BACKGROUND OF ORGANIZATIONAL THEORIES

A. ENVIRONMENT AND ORGANIZATIONAL STUDIES

1. Weber's Bureaucratic Theory

Weber (1921) predicted that the growth of many large organizations would prompt a formalized process of coordination and control. He termed this structure bureaucracy, an efficient organization that could deal with an increased tempo of operations and information flow. Weber's bureaucracy included (Dessler, 1986):

- A well-defined hierarchy of authority
- A clear division of work
- A system of rules covering the rights and duties of position incumbents
- A system of procedures for dealing with the work situation
- Impersonality of interpersonal relationships
- Selection for employment and promotion based on technical competence.

This style attempts to minimize human factors such as bias (in judgement and interpersonal relations) and emotion in the work process, while optimizing characteristics such as efficiency, precision, speed, process continuity and unity, and procedural clarification.

2. Burns and Stalker

Burns and Stalker (1961) studied more than 20 industrial firms that were organized to perform under relatively stable conditions and observed their responses to new and unfamiliar tasks. Burns and Stalker believed that when an organization's

new and unfamiliar tasks. Burns and Stalker believed that when an organization's environment starts changing rapidly, "a fundamentally different kind of management system becomes appropriate from that which applies to a relatively stable commercial and technical environment." They classified organizations as mechanistic or organic, depending on the environment in which they operate. Dessler (1986) describes three types of environments, with their distinguishing characteristics listed below.

Stable Environment:

1. Demand for the organization's product or service is stable and predictable.
2. There is an unchanging, stable set of competitors.
3. Technological innovation and new-product development are evolutionary rather than revolutionary, in that the required product changes can be predicted well in advance and the required modifications can be made at a leisurely pace.
4. Government policies regarding regulation of the industry and taxation are stable and change little over time.

Changing Environment:

1. Demand for the organization's product or service fluctuates but can still be predicted with some accuracy several years in advance.
2. Competitors enter and leave the industry, but although these changes can affect the firm's demand, the effects are usually not drastic.
3. Technological innovation and new-product development proceeds in an orderly, sequential fashion, with the required changes well understood a year or more in advance.
4. Government policies regarding the regulation and taxation are changing, but these changes can generally be predicted well in advance and planned for.

Innovative Environment:

1. Demand for the organization's product or service can change dramatically, sometimes overnight, as competitors introduce radically improved products.

2. Sudden, unexpected changes occur in the nature of the organization's competitors.

3. There is an extremely rapid rate of technological innovation and new-product development. Organizations in innovative environments usually rely heavily on research and development for their survival.

4. Government policies regarding regulation and taxation are evolving quickly, trying to keep pace with the stream of new, more technologically advanced products being introduced by firms.

A mechanistic organization is one with a clear hierarchy of authority and many rules, and is best suited for stable markets. Organic organizations are more fluid, with few rules and much communication in all directions. Responsibilities and its hierarchy are undefined, enabling it to effectively operate in an innovative environment.

3. Lawrence and Lorsch

Their studies (1967) showed that in large, multi-departmental organizations, each department must contend with a different environment and therefore have its own structure. The total task of the organization must be divided into a series of subtasks (differentiation) and these organized in such a way as to facilitate effective performance (integration). Their findings showed that the more differentiation there was between departments, the more elaborate the integration methods required.

4. Emery and Trist

Emery and Trist (1965) described four types of environments with which organizations must cope. They illustrated how an external environment can evolve over time from simple and stable to complex and dynamic. The four types of environments are summarized as follows:

- Type 1 (Placid and randomized): This is the simplest type of environment. The organization cannot predict what it will do, but it operate relatively independently of it. Learning is by trial and error.

- Type 2 (Placid and clustered): The environment changes slowly and probability estimates of expected results of an action can be made. Knowledge of the environment is critical to the survival of the organization and strategic planning must be done for proper resource allocation.

- Type 3 (Disturbed and reactive): This is similar to a type two environment except that now there are several similar types of organizations operating in the market. Now consideration must not only be given to the reaction of the market and the organization's long term goals, but to probable competitor reactions as well. Dealing with competitor reactions requires greater flexibility.

- Type 4 (Turbulent field): This is the most complex and rapidly changing environment and exists as a result of three interrelated trends. First, by adapting to a type three environment, organizations link and begin to alter the nature of the environment. Second, there evolves a "deepening interdependence between the economic and other facets of the society" (Emery and Trist, 1965). The final trend is a marked increase in research and development efforts, which in turn establishes a continual pattern of change in the environment.

B. TECHNOLOGY AND ORGANIZATIONAL STUDIES

1. Woodward

Woodward (1965) examined how organizational form varied with the type of product manufactured or the technology used. She studied over 100 firms that employed over 100 people. This sample covered a range of businesses, with approximately half of

them being mechanistically structured and the other half organically organized. Through interviews and observation her group identified differences in structure and management practices. The differences did not relate to size, industry category, or degree of success. When they grouped the organizations according to their technology into the three groups defined in Chapter One, it was seen that different structures were appropriate for different technologies. Routine technologies allow the use of extensive rules and procedures because the job is well-defined and repetitive whereas technologies consisting of unanalyzable tasks require more discretion and is reflected in the organizational structure and control systems. Woodward's own conclusions concerning these differences in structure were that they were due to the differing degree of coordination required.

Two observations were that line managers in unit and process firms were expected to have greater technical expertise and to make technical decisions and that there were more skilled workers in the unit and process firms.

2. Aston Group

The members of the Industrial Research Administration Unit at the University of Aston conducted a survey of 52 organizations, including 31 manufacturing firms (Pugh, Hickson, et. al., 1969). The results were diametrically opposed to Woodward's findings in that an organization's size is the determining factor of its structure, not the technology it uses.

The study assumed that many variables could influence structure, including organization origin and history, ownership and control, size, charter (purpose and goals of the firm), technology, location, and dependence on a supplier or parent firm. The team found size, dependence, and inter-related charter/technology/location factors to be the

prime structural determinants and conducted a second study to specifically examine the technology-structure relationship.

Next, the Aston group focused their research on the *operations* technology, or the techniques used in workflow activities, of 46 randomly selected firms, which considered four factors (Dessler, 1986):

1. *Automaticity*, the degree to which the production process is automated.
2. *Work-flow rigidity*, how rigid (versus adaptable) the work-flow process is. For example, in the event of a breakdown, does all work flow stop immediately?
3. *Specificity of evaluations*, or how precisely performance could be measured against formal criteria.
4. Finally, the Aston group also measured technology using a production "continuity" similar to Woodward's unit-mass-process production continuum.

The results of this study again showed that size, not technology was the major determining factor of organizational structure.

3. Blau

Blau (1976) conducted interviews in 110 New Jersey manufacturing plants to determine how technology influenced organization structure. In his initial study, he tested the *linear* relationship between technology and each dimension of organization structure using techniques similar to those of the Aston group. Blau found that organizational size seemed to influence structure. Technology seemed to have little relationship to structure and that the relationship was no stronger in departments close to the production floor level in the organization.

Blau then conducted another study (1976) that categorized firms according to Woodward's production categories and statistically tested the *curvilinear* relationship between technology and structural dimensions. The findings were now very similar to Woodward's. This indicated that unit and process production firms were similar and differed from mass production firms, tending to be more organically organized while mass production firms tend to be mechanistically organized. This and other findings (Marsh and Mannari, 1981) suggest that certain aspects of structure are a function of technology, while others are size dependent.

4. Perrow

Perrow (1970) believes that all organizations are designed to do work, and technologies are tools used to do this work. The nature of its technology determines an organization's structure. He defines technology as the process an individual uses to react to stimuli and complete his or her task and claims that two basic dimensions of technology must be considered, task variety and analyzability. Variety considers the routineness of the stimuli and analyzability considers presence of formulated search behavior when dealing with exceptions. Perrow developed a matrix (Fig. 1) to describe technology.

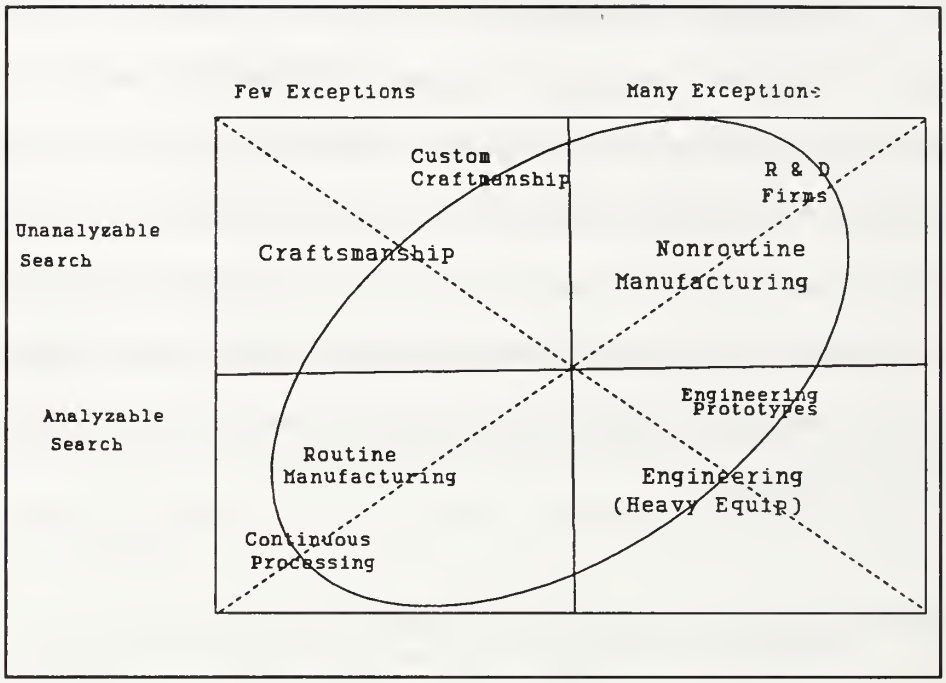

Figure 1: Technology Matrix by Charles Perrow

C. UNCERTAINTY, COMPLEXITY, AND ORGANIZATIONS

Although not all of the studies described above agreed with each other, an underlying theme of uncertainty was present. Mintzberg (1983) noted that "it is not the environment per se that counts, but the organization's ability to cope with it-to predict it, comprehend it, deal with its diversity, and respond quickly to it that is important." Galbraith (1977) defines uncertainty as "the difference between the amount of information required to perform the task and the information already possessed by the organization." He contends that organizations are structured to process information, and the structure it chooses is based on the amount of uncertainty it must deal with and information it must process.

III. REVIEW OF LITERATURE ON ORGANIZATIONAL STRUCTURE IN INFORMATION SYSTEMS

A. GALBRAITH

Galbraith describes two ways to increase information processing capacity. The first is to develop a formal information system, the second is to develop lateral relations across functions through liaisons, teams, task forces, and committees. These two strategies should be pursued together since one is technological and the other is structural.

1. Organizational Design Strategies

The purpose of organization design strategies is to increase the capacity of an organization to process information and make decisions. As the amount of uncertainty in an organization and the number of exceptions to the governing rules and policies it must deal with increases, the organization must provide better, more expensive methods for processing information. Galbraith's continuum of organization design strategies for dealing with uncertainty is shown in the figure on the following page. When the number of exceptions to the production process increases beyond the capability of the hierarchy to support, new design strategies must be employed. The design may serve to either reduce the number of exceptions to process or increase the capacity to handle information. Exception reduction can be accomplished through the creation of slack resources or the creation of self-contained

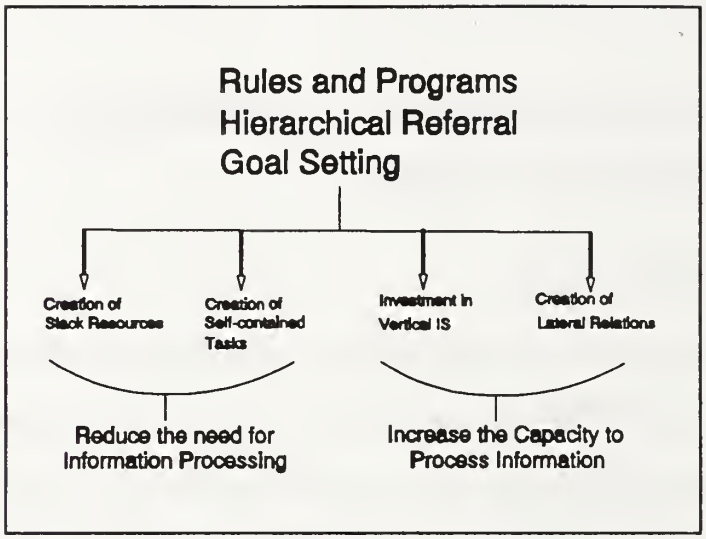

Figure 2. Organization Design Strategies (J. Galbraith; Designing Complex Organizations)

tasks, while increasing information processing capacity is done through creation of vertical information systems or lateral relations.

The focus of most literature concerning organizational structures with regard to information systems is on increasing information processing capacity, so those methods are the only ones dealt with here in detail.

a. Dimensions of Vertical Information Systems

Four policy variables are involved in considering the scope of the development of a vertical information system, these include:

(1) Decision frequency or timing: The frequency of the occurence of the goal-setting or decision-making process affects the number of exceptions that need to be referred up the hierarchy. As the uncertainty of the task increases, the interval between planning sessions decreases, and the shorter the interval, the fewer the exceptions

generated. This reduction is at the cost of increased processing requirements (i.e. planning twice per month requires more processing than only planning once a month).

(2) Scope of the Database: Increasing the scope of database contents means an increase in development, operations, and maintenance costs. To avoid sequential processing through hierarchical channels and reduce filtering and delays, a global database can be implemented using a direct information channel to a position in the hierarchy capable of making the required decision. Bringing information to points of decision has as its primary virtue the avoidance of the problem of behavioral control over a subunit. The decision is now based on the goal of the unit instead of the subunit. So, global goal orientation is brought down to the lower levels of the hierarchy.

(3) Formalization: This is the specifying of standard rules, terminology, and procedures to permit transmission of information using fewer symbols, so communication channels can carry more information without physical expansion. The more formal the information system, the fewer resources consumed in the transmission. Not all types of information can be formalized, and unique and non-routine events (exceptions) still require non-formal methods of communication. It is the type of uncertainty in which known factors may acquire unknown values that can be effectively handled by formalization rules.

(4) Decision Mechanism: The capacity for decision making must be expanded with respect to the previous three policy variables. Decision making can be enhanced in two ways:

1. Group Decision Making, which provides better quality decisions and produces a higher motivation to implement the decision.
2. Machine Technology, programming machines as decision mechanisms have substantially reduced slack in manufacturing firms.

Man-machine decision mechanisms is another area being explored. This relationship allows an individual to concentrate on creating alternatives and evaluating the consequences while the computer does the manipulation on large volumes of data to compute outcomes of various decision alternatives. This sort of detailed trend analysis was unavailable to decision makers before the advent of computers enabled the manipulation of vast quantities of data.

b. Dimensions of Lateral Information Systems

The function of this design strategy is to develop lines of communication laterally along the hierarchy as opposed to a vertical communications structure. The purpose, as with other strategies, is to decrease the number of decisions being deferred upward. Discretionary decision-making is placed at lower levels in the organization, which also increases the timeliness of decisions.

Many of these relations are informal, but their efficiency can be improved by designing them into a formal organization. Galbraith (1973) lists several forms of lateral relations, some of which are listed below:

1. Use *direct contact* between managers who share a problem.
2. Establish *liaison roles* to link two departments which have substantial contact.
3. Create temporary groups called *task forces* to solve problems affecting several departments.
4. Employ groups or *teams* on permanent basis for constantly recurring interdepartmental problems.
5. Create a new role, an *integrating role*, when leadership of lateral processes becomes a problem.
6. Shift from an integrating role to a *linking-managerial role* when faced with a substantial differentiation.
7. Establish dual authority relations at critical points to create a *matrix design*.

2. Four Prototypes of Information Systems

a. Local Periodic

Because of the limited scope and timeliness, this system is not extensively used. It involves periodic information input by a subunit based on the subunit's own requirements, with no consideration for interdependence with other subunits. It is not a real time system and is unresponsive to an uncertain environment.

Its utility is limited to the optimization of a subunit's operation and not the organization as a whole.

b. Local Real Time

Data collection is largely done informally on a continuous basis. Decisions are man made as needed to prioritize the requirements and demands placed on the subunit. This permits the most efficient use of a department. The primary drawback to this system is its locus, the optimizing of efficiency, is done on a local level and not organization-wide. Prior to computerization this was the primary way to respond to uncertainty.

c. Global Periodic

Computer uses data to schedule all similar job shops in a company, knowing the organization's order requirements. This system uses formalized information collection and machine-aided decision making processes. This system can consider departmental interdependence, but since it is a periodic system, its schedule is still subject to a decay process due to ongoing changes in requirements. Whisler (1970) studied 23 insurance companies in which they changed from a local real time to a global periodic

structure using computers. The following organizational changes were noted (Galbraith, 1973):

1. Computerization resulted in an average personnel staffing reduction of 60 percent in clerical billets, nine percent in supervisory billets, and a two percent reduction in managerial positions.

2. In all the companies studied, decision making areas were integrated and consolidated, so it appears that ...computer systems reverse the effects of organizational growth and development, restoring fragmented decision systems to the state of integration that would have been logically and economically desirable had it not been for acute problems of information overload (Whisler).

3. An organizational consolidation was also observed in the form of a reorganization of self-contained departments into functional departments. This was now possible since the computer reduced information overload and made the efficient operation of functional departments possible, as well as enabling coordination of these specialized units. This changed was not seen in all the companies, those dealing with greater uncertainty maintained self-contained structures.

4. Most companies reported greater centralization of decision making or the movement of the decision authority to a higher level. This is in line with the greater subtask interdependence of a functionally organized organization.

5. Several organizations reported more group decision making being used as a strategy for coordination.

These findings support Galbraith's theory that ..."the use of computers in the modification of the vertical information system is an alternative to the creation of self-contained structures in handling information overloads" (Galbraith 1973).

d. On-line Real Time

This system supports the continuous flow of global real time data and man-machine involvement in decision making. It permits inter-unit consistency of action to support organizational goals and reduces decay of plans by responding to new situations as they develop. However, Galbraith maintains that remote-access and time-shared computers are expensive to acquire and maintain. This observation may be

somewhat dated in view of today's computer technology-to-price ratio. He also cites an inability to create new organizational structures to fully use computers, whether due to cultural lag or the difficulty to implement sweeping changes in some of today's more gargantuan organizations.

B. DESIGNING FOR INFORMATION PROCESSING CAPACITY

Organizations must respond to both internal and external uncertainty and can be thought as a structure designed to process information.

Van de Ven (1976) states that there three sources of work related uncertainty (subunit task characteristics, subunit task environment, and inter-unit task interdependence) need to be considered when designing an organization's exception handling capacity. The more routine a task, the less information processing requirements associated with it. As the task environment becomes more dynamic, an organization must be able to deal with increased uncertainty and thus needs a greater information processing capability. The greater the inter-unit task interdependence, the greater the required information processing capability.

The greater the exception processing capability of a structure, the more expensive and complex it is. Tushman and Nadler (1978) propose that organizations are more effective when there is a match between the information processing capabilities facing the organization and the information processing capacity of the organization's structure.

IV. IMPACT OF ORGANIZATIONAL STRUCTURE ON INFORMATION SYSTEMS

A. EIN-DOR AND SEGEV

Ein-Dor and Segev (1981) divide MIS into two general categories: design-oriented and use-oriented. Design-oriented refers to the hardware, software, database, and other components; use-oriented refers to management which is done in terms of the function of a system in relation to the organization. Use is their prime criterion for determining MIS success.

Drawing data from a survey of scientific, managerial, professional, and trade literature on the concentration and use of MIS, Ein-Dor and Segev propose that there are several organizational context variables that affect the success or failure of MIS. These variables are categorized as uncontrollable, partially controllable, and controlled. An example of a variable that is completely controllable by top management is the rank and the location of the responsible executive of the steering committee. Those variables that are partially controllable include the availability of organizational resources, the maturity, or formality of the organization, and the psychological climate of the organization regarding change. Some uncontrollable variables include organization size, structure, extra-organizational situation, and the time frame for implementation.

1. Uncontrollable Variables

Ein-Dor and Segev propose that the likelihood of building a successful MIS at the corporate level of management increases as the degree of centralization of the portion

of the organization reporting to that level increases. There is a relationship between the organizational structure and the best degree of centralization of IS resources.

They contend that the smaller an organization, the less likelihood of success for an MIS. There are many factors working against a small company, including time frame available for software development and implementation, organization maturity, and resource availability in the form of cash and skilled personnel. This may be true for user-made systems, but off-the-shelf and turn-key systems may eliminate these disadvantages. With the technological advances made since their proposals, smaller firms can increase their levels of MIS sophistication and success. Study results regarding size and MIS sophistication have been mixed.

The longer the organizational time frame available, the greater the likelihood of IS project success. This is most applicable to higher levels of management, where problems are generally unique and non-recurring. However, when longer time frames are used, managers tend to bypass the information system in their search for solutions. The environment in which the system is embedded, the industry it is in, and its size affect the organizational time frame.

When considering the external environment, the more plentiful the requisite resources, the greater the likelihood of MIS success.

If the uncontrollable elements are benevolent enough to permit a successful program of implementation or change, the partially controllable variables should then be analyzed.

2. Partially Controllable Variables

The budgeting of sufficient resources increases the likelihood of MIS success. Since the benefits of an information system are often intangible, it is difficult to justify to budgeteers. This becomes increasingly true with the decision support systems used at higher levels of management. Also, the more easily an organization can translate its MIS budget into the requisite resources, such as personnel, programs, and hardware) the greater the likelihood of success.

The maturity of an organization has no relationship to the chronological age of an organization. Maturity refers to the degree of formal organization, how well understood and quantifiable their process is, and that relevant data are available to management. The more mature an organization, the greater the likelihood of successful MIS implementation since they provide a more compatible environment for the development and usage processes of computer-based systems. Because of their complexity, larger organizations tend to be more formalized in their procedures and communications, providing a convenient basis for MIS development.

The psychological climate is a factor in MIS success in that a project "will succeed to the extent that expectations are constrained by the motivation from below and reality from above" (Ein-Dor and Segev, 1981). The organization must guard against both excessive downplaying and over expectation. Expectations and preconceptions play a predominant role in establishing the psychological climate in an organization before the installation of MIS. The climate is also affected by the experience with the MIS.

3. Fully Controllable Variables

The likelihood of the success of an MIS rapidly decreases the lower the rank of the senior MIS executive to whom the MIS chief reports. It is nearly negligible if the executive is more than two levels below the chief executive of the organization which the MIS serves.

The likelihood of MIS success is increased in an organization where the steering committee is a high level group. Since the steering committee is usually seen as a sign of management support, a favorable psychological climate is also established.

B. MANAGING THE IS FUNCTION

According to Zuboff (1989), the source of competitive advantage is having an organization that can exploit information to learn and innovate more quickly than its competitors. Technology now enables you to first develop the people and structure that best enables the organization to satisfy the needs of its marketplace and then develop the information system to support it.

The structure and importance of information systems has changed and the executive steering committee is the most effective way to ensure that the IS function fits the corporate strategy. Two tendencies are leading companies to form committees; decentralization and strategic choice by top management. Smaller and cheaper computers make more decentralized structures feasible.

Computer technology offers an economic tool to improve almost all aspects of business operations, "... planning for computers has changed its objectives from linking Data processing strategy with business strategy to linking computer technology strategy

with business strategy" (Nolan, 1979), so organizations must now make choices among many possible uses for finite computer resources. The information required to make these strategic choices effectively must come from senior management executives that have a business perspective of the organization as a whole.

In examining the best degree of centralization or decentralization, organizational constraints must be considered. According to Reichenbach and Tasso (1968), "... it is the underlying characteristic management style that is the significant factor in the determination of how centralized electronic data processing should be ...". Decentralization is a multi-faceted problem and there are three separate information system functions that can independently considered for decentralization. These are systems operations, systems development, and systems management.

Systems operations includes the physical computer hardware and the operations personnel associated with it. The argument for centralization has traditionally been that of economies of scale, but with current technology, minicomputers and distributed computing can provide decentralization at a relatively low cost. Today, smaller computers are actually cheaper than mainframes based on the cost per million instructions per second (MIPS) of processing capability.

Systems development includes the analysis, design, and programming of new applications, and the maintenance of existing ones. The key issue here for decentralization is the desired degree of user involvement. An example of extreme centralization is the assignment of all personnel in a central pool from which they are assigned. An example of extreme decentralization is the physical location of systems analysts to user departments, to whom they also directly report.

Systems management includes the administrative aspects of planning, developing, and controlling Information Systems resources. These facet is concerned with the location of executive responsibility for information services, whether it is decentralized in the form of user management or managed centrally by a steering committee.

C. NATURAL FITS OF COMPUTER-BASED INFORMATION SYSTEMS AND ORGANIZATIONAL STRUCTURE

The impact of a computer-based IS on organizational structure will be affected by the fit between the structure and the information system (Leifer, 1988). Matching the IS with the structure reduces resistance because power structures, responsibilities, and job definitions do not change much.

Information systems can be characterized by their architecture or topology, which is the set of interconnections of nodes in a network. There are four types of computer-based information systems that will be considered (Leifer, 1988):

- **Centralized**: Designed around a central processor or main frame using "dumb" terminals. This usually supports interactive forms of transaction processing.
- **Distributed**: This is a peer-to-host system designed as spokes of terminals around a central processor or main frame. Terminals may have their own storage devices, processors, data bases, and computing capabilities. Users can communicate with each other through the host.
- **Decentralized**: These are also known as "peer networks". There are more degrees of freedom of communication since there is no central processor through which traffic must pass. Users now have the ability to communicate interactively with particular individuals or groups. This flexibility provides the capability to deal with a wide variety of informational requirements.
- **Stand-Alone**: Since PCs are now a relatively low cost tool, most larger organizations do not plan for them (LaPlante, 1987) and the operations they support are geared towards the individual, not the organization as a whole.

The typology of organizational structures was discussed earlier in Chapter One. The five structures considered are simple structures, machine bureaucracies, professional bureaucracies, and A and B divisionalized forms. Organizations are mixtures of these idealized forms and often several forms of IS will also co-exist within an organization. The unit level of analysis should take place at the level where task-related communications regularly takes place. Leifer (1988) identified several IS-organization matches, where the IS is complementary to the actions and behavior of the organization and its culture, which reduces resistance to the acceptance of an Information System.

1. Simple Structures and Stand-Alone Systems

Information processing capabilities are generally limited to that of the CEO and data gathering is done informally by personal contacts. Most usage of personal computers is to enhance individual performance rather support the overall company IS.

2. Machine Bureaucracy and Centralized On-line Systems

The IS primarily deals with the computerization of the paperwork processes of the firm. The IS structure is well-suited to monitoring, control, and routine data processing and fits well into machine bureaucracies (mechanistic organizations) where control and monitoring are strategic necessities. Effective performance of centralized IS tasks requires rules and policies that are consistent with the tasks of the organization.

3. Professional Bureaucracy with Centralized and Distributed Systems

Since there is relatively little task-oriented information processing among colleagues, most coordination is performed by administrators, and most information needs

are in the form of historical or specialized task knowledge. Administrative and professional users use the hardware systems in parallel and do not interact with each other. In such a system, the need for autonomy and localized information processing by the professional is preserved, as is the need for control by administrators.

4. Divisionalized Designs and Information Systems

a. Form A

Since divisions are only loosely coupled to the strategic apex, Leifer expects the IS to vary from division to division. The semiautonomous units (strategic business units or SBUs) are large and homogeneous enough to exercise effective control over most factors affecting their businesses. The IS are based on the organization of the SBU and reinforces its strategy and structure rather than that of the rest of the organization. So, a centralized IS would be expected in a SBU that was organized as a machine bureaucracy and a combination distributed and centralized IS in one that was organized as a professional bureaucracy (Leifer, 1988).

b. Form B

With Form B divisionalization, there is a greater sense of inter-unit cooperation and support, and the use of a cross-divisional IS. Leifer and Triscari (1987) found that a decentralized IS leads to increased information processing capability, increased volume of information processing, more personalized contacts, and more task focused interactions. Decentralized systems assist the organization in adapting to environmental changes. Since Form B structures are associated with decentralization, organizational flexibility, and increased information processing needs, they would be best served by a decentralized IS.

5. Adhocracy and Decentralized Systems

In an adhocracy, high information processing capabilities are needed (Leifer, 1988). This can be accomplished with mutual coordination, task forces, and a decentralized IS. Communications need to be widely dispersed and available, and to do this successfully, the size of the adhocracy must remain small. The resulting information flows and unit flexibility create a relatively flat organizational pyramid, enabling innovation and fast response. Since a decentralized IS can enhance the quality and quantity of information, it is a vital component of the adhocracy's decentralized structure.

D. STRUCTURAL DEVICES

There are several different manners in which the IS personnel may be used and integrated within the organization. They vary in their flexibility for adapting the IS system to changes, task division, and amount of user involvement.

1. Departmental organization

IS departmental organization has traditionally accomplished its function in the following manners (Nosek, 1989):

a. By development phase

This is the most traditional sort of organization. With this structure, divisionalization is broken down by development phases such as analysis, design, programming, and maintenance. A spinoff on this is developing the system in an evolutionary fashion, due to the inability to specify requirements in advance. The feedback loop is shortened with the intent that at the end of each cycle in the system development

the users are provided with a new, at least partially usable version of the system. This demands a more integrated and interactive process than conventional, one cycle processes, but provides a more usable and easily maintainable system.

b. By project

This is a more organic organization, in which project groups are responsible for all phases of a project's life, from analysis to maintenance. This removes any stigma from the maintenance phase, and has the advantage of "organizational memory", in that the people who developed the system can interpret the users requests better. There is also better likelihood of a well-designed, easily maintainable system since the developer knows he will also be performing the maintenance on the system.

2. Steering Committee

The purpose of a steering committee is to link computer strategy with the organizational business strategy by setting a strategic direction and determining the multi-year financial commitment. The committee provides five essential functions (Nolan, 1982): direction setting, rationing, structuring, staffing, and advertising and auditing.

The committee sets the objectives for computer usage and formulates the strategy to focus on these goals, devises policies to ensure that the organization's actions are consistent with these goals. They also reconcile the commitment of the company's resources to computers with their commitment to other business activities.

The committee also examines the appropriate structuring for an organization to ensure the effective use of computers. It deals with the centralization versus decentralization issues. Staffing of computer related positions is a difficult function that

is usually conducted by the steering committee after it has been in existence for two or more years.

Advising and auditing are conducted to keep computer activities on track and a good statement of objectives and a long-range plan is essential to this function. The audit should be conducted, by an outside source to ensure objectivity, on an annual basis. "The audit review plays a central role in helping the committee learn about current opportunities and issues in applying computer technology" (Nolan, 1982).

As with other facets of computer technology, the function of the executive steering committee will evolve over time. One pitfall Nolan warns of is trying to accomplish all of the previously described functions during its initial meeting. A stepwise approach is recommended in which direction-setting is first addressed. In the second year, attention is focused on rationing; years three and four focus on advising and auditing; years four and five on structuring, and year five on staffing as well.

Finally, Nolan points out that committees must be aware that strategic issues involving computers change over time and management problems for computers have also changed. Since the data processing manager does not have a broad enough view of the organization to provide the leadership, this void must be filled by the executive steering committee.

3. Co-ownership

Nosek (1982) describes this as an example of a truly organic structure which uses a two-tiered, hybrid partnership relationship between line and IT management to provide support and control costs. The first tier is a competitive arena in which all users compete for the use of the company's data processing resources. If, based on

organizational goals, an IS project is determined to be of a high priority, it is developed at the second tier level, that of co-ownership between the user department and the data processing department. Any changes that conform to the original scope of the project can be made as needed after the project is completed. The designers and users work together and the feedback loop is much shorter than those with conventional user-developer relationships. However, any requests for changes that are beyond the scope of the initial project must be examined at the first tier and compete with other projects for data processing resources.

E. VARIOUS EXPERIMENTS TO SUPPORT

1. Olson and Chervany

Their study (1980) examines the relationship between organizational characteristics and the structure of the Information Services function. It is a field survey of corporate executives and information processing managers in 43 business organizations in a medium-sized metropolitan area. The organization sizes were broken into three classes based on number of employees; 500-2000, 2001-4000, and 4001 or more. The focus was on the type of technology employed (job shop vs. batch vs. continuous process) rather than types of products manufactured. Six organizational characteristics were considered. These included:

1. Centralization of authority, or level in the organization where most operational control decisions are made.
2. Standardization.
3. Formalization.

4. Line control of workflow. This refers to the control procedures applied to the operations process. They can be impersonal control mechanisms to minimize direct communications or direct supervisor-subordinate interaction.

5. Functional specialization, or the number of functions in the organization performed by specialists.

6. Perceived power of the Information Service function. This is the influence that the IS department has on the user department as perceived by the user.

Several characteristics were considered for the three Information System functions. Based on these, Chervany and Olson classified organizations as highly centralized, highly decentralized, or at a middle level.

The factors concerning systems operations were the number and location of computer facilities, the range of work performed at each facility, the location of the control over the operations (degree of local autonomy over local processing), and the location of stored data.

The factors concerning systems development were the location of the systems analysts, the method of project assignment, and the existence of other communications mechanisms. The last two characteristics apply to centralized design groups. The method of project assignment considers whether they are pooled or permanently assigned to user departments. The existence of other communications mechanisms considers liaison with the user departments, if a formal position is established, the staff is considered more decentralized than if one did not exist.

The factors concerning systems management were the method of project selection, the method of charging for services, and the degree of user control over project costs and management. Project selection may be conducted as a process of negotiations between the user department and the IS department, usually in conjunction with the budgeting process.

Other methods of selection can be by steering committee, or the user departments can set the priorities. For system operations, the degree of the centralization of hardware was not found to be related to any of the organizational characteristics. In companies utilizing centralized system development, the use of mechanisms to increase user involvement in the development process was influenced by organizational characteristics. When considering system management, companies that charged back fully for computer services tended to have centralized decision making authority, which was contrary to researcher expectations of full chargeback in decentralized companies. The rest of the findings from this survey are shown in the tables on the following page.

There were several unexpected relationships found in this survey. Contrary to researcher expectations, few characteristics of the IS service were found to be related to the centralization of decision making authority within the organization. The only relation found between decision making and system development was that decentralized organizations tended to use liaison positions to improve communications between the data processing and user departments.

Decentralized organizations did not exhibit a greater tendency towards decentralized operations control than centralized organizations. The location of the hardware was not related to organizational characteristics, so the location of the machines does not have to be related to the organizational structure, it appears to be determined by physical constraints such as geographic location of user sites and economies of scale. Of the system management functions, only charging for services seemed to be related to centralization. Finally, industry and size classifications appeared to have no influence on the organization of the information services department.

Table 1. SUMMARY OF RELATIONSHIPS FOUND BETWEEN SYSTEM OPERATIONS AND INFORMATION SERVICES CHARACTERISTICS

System Operations Organizational Characteristic	Information Services Characteristic
High function specialization within the organization	Greater decentralization overall
	Greater autonomy of local sites
	More decentralization of operating data
	Greater autonomy of local sites
High standardization of procedures within the organization	More processing at local sites
High line control of the workflow	Greater autonomy of local sites

Table 2. SUMMARY OF RELATIONSHIPS FOUND BETWEEN SYSTEM DEVELOPMENT AND INFORMATION SERVICES CHARACTERISTICS

System Development Organizational Characteristic	Information Services Characteristic
High functional specialization within the organization	Greater specialization to users of project assignments
High formalization of documentation within the organization	Greater decentralization overall
Decentralized decision making authority	More use of formal liaisons to improve communications

Table 3. SUMMARY OF RELATIONSHIPS FOUND BETWEEN SYSTEM MANAGEMENT AND INFORMATION SERVICES CHARACTERISTICS

System Management Organizational Characteristic	Information Services Characteristic
High formalization of documentation within the organization	Greater steering committee control over project selection
	Greater control over project management
	Greater frequency of full chargeback for services
Centralized decision making authority within the organization	
Low line (high impersonal) control of the workflow	Greater user control over project selection
Low perceived power of the IS function	Greater steering committee control over project selection
	Greater user control over project management

The researchers could not conclude when or why decentralization of the IS function occurred. The following conclusions were made by Olson and Chervany (1980).

a. System operations

1. Location of machines is not affected by organizational factors and is probably primarily an economic decision.
2. It is possible to increase the degree of user control over their own operations regardless of the location of the hardware.
3. The degree of decentralization of operations is related to standardization, functional specialization, and line control within the organization.

b. System Development

The study showed that there are several ways to decentralize control over system development without physically decentralizing systems analysts (Olson and Chervany, 1980) . In companies with high functional specialization, specialization of the systems analysts can be achieved by permanent assignment of an analyst to all systems for a particular functional user area. In decentralized organizations, it is important that a centralized staff have good user liaisons to promote user involvement in project development.

c. System Management

Decentralization of control was greatest in organizations where users controlled both project selection and management. Control was centralized when users had no control and were charged for services. Few companies in the survey were found to use steering committees to increase user control over information services, although several had previously used them and dissolved them due to their ineffectiveness.

2. Impact of Organizational Size and Structure on Microcomputer Adoption

In this study (Lind, Zmud, and Fischer, 1989), data were collected from 21 firms to observe the impact of organizational size and structure on the adoption of microcomputers. The structural characteristics were measured as organizational links (lateral relations) between the information systems area and users of microcomputer technology (Lind, Zmud, and Fischer).

The total number of microcomputers in use indicates the degree of microcomputer technology adoption. Linking mechanisms are structural alternatives to traditional bureaucratic structures through which an organization's units cooperate in performing work. As the IS department becomes more involved in distribution and technology transfer, lateral relations between the users and the IS department become increasingly important. For users throughout an organization to make effective use of microcomputers, there needs to be an infrastructure consisting of generic hardware and software tools. Linking mechanisms are critical in such an infrastructure.

> The microcomputer infrastructure of an organization can be described as its core ability to support end-user information processing activities. This infrastructure consists of computers, software, databases, and communications capability that allow the organization to process information. The nature of this infrastructure can enhance or constrain end-user computing (Lind, Fischer, and Zmud, 1989).

In this study, structure is a variable that measures the extent that linking mechanisms are used to support user microcomputer use in terms of access to both the technical infrastructure and sophisticated applications. A high score on structure means that link were frequently used by the IS function to support users in the specified microcomputer support areas.

The results showed that the belief that organization size is a significant predictor of microcomputer adoption could not be rejected. This supports the proposition that size can provide an explanation for technological innovation even, in the early stages of a technology's development (Lind, Zmud, and Fischer, 1989). This is due to a larger organization possessing a greater quantity of resources to devote to their microcomputer structure.

Organizational structure was shown to be significantly related to microcomputer adoption. The study showed that when large organizations provide linking mechanisms they had a higher adoption rate than firms that do not provide such linkages. This suggests that in order to manage and coordinate between a large number of resources and activities, lateral and hierarchical relationships between the IS department and the users were needed.

The proposal that linking mechanisms supporting the technical infra-structures are more effective at promoting computer adoption than those that support sophisticated applications of firms in the early stages of end-user computing could not be rejected. Linking mechanisms targeted at building and supporting the technology infrastructure were most effective in organizations primarily in the early stages of adoption.

This study showed that both size and structure appear to play important roles in microcomputer adoption.

3. Relating Organizational Context to IS Success

This paper (Raymond, 1990) focuses on developing a model to relate selected variables of organizational context, namely size, maturity, resources, time frame, and IS sophistication to system success.

All variables except IS sophistication are discussed earlier in this chapter when discussing Ein-Dor and Segev's proposals. IS sophistication is a fully controllable variable that deals with the organization's managerial and technical sophistication in implementing, operating, and using its information system.

IS success is evaluated using two methods. The first is a behavioral approach based on off-line and on-line system usage. The second approach is based on user attitudes as derived by user satisfaction with various aspects of the information system.

Raymond (1990) used a sample consisting of 34 manufacturing firms in the wood and metal products sector of three geographical regions of Quebec. Eighteen were considered small (10-50 employees), and 16 were medium-sized (51-250), with a median computer experience of three years. An average of three direct users were interviewed in each firm.

The hypotheses tested were grouped into three sets. The first set of hypotheses were taken from Ein-Dor and Segev's initial model and tested factors influencing IS success. The second set of hypotheses tested was derived from their initial assumptions and later empirical findings on the existence of relationships between organizational structure and the sophistication of the IS structure. Lastly, the relationship

regarding IS sophistication and success of the MIS was examined. The results observed in this study are presented below.

a. Organizational Context and IS Success

Size was found to be positively related to the organizational measures of both user satisfaction and on-line usage. There was however, a lack of relation between size and off-line usage. Organizational maturity was also found to be positively associated with satisfaction and off-line usage.

There was no evidence to suggest that the level of IS success increases with the amount of organizational resources allocated to it. Raymond (1990) argues that this may indicate that the investment in human resources, not computer hardware and software, is crucial to successful implementation.

A positive association between a longer organizational time frame and two of the success variables, satisfaction and on-line usage. A longer time frame was not significantly associated with a higher level of off-line usage, which could be attributed to the nature of most batch reporting systems. Raymond reports that managers use the printed outputs provided by these systems mostly for control purposes, whereas computer support of planning tends to be much more interactive, including on-line interrogation and analysis capabilities.

b. Organizational Context and IS Sophistication

Larger firms tended to have a more sophisticated IS function. This sophistication is believed to be an indirect consequence due to larger firms having more resources to allocate to their IS function. It was also shown that more mature

organizations also tend to possess a higher level of IS sophistication, using inventory control, quality control, budgeting, and financial analysis techniques, which provides a more compatible environment for the development and usage proce sses associated with computer-based systems.

The level of IS sophistication increased as more organizational resources were allocated to the IS function. No support was found for the hypothesis that firms with a longer organizational time frame possessed a more sophisticated IS function.

c. IS Sophistication and IS Success

Confirming evidence was found for the relationship between IS sophistication and MIS success, in that a higher level of IS sophistication positively influences the level of system success within the organization. This was true in terms of user satisfaction and off-line usage, but less so in terms of on-line usage. A possible explanation given by Raymond as to why IS sophistication has less influence in this case was that the voluntary nature of on-line systems use by managers, especially when the organizational time frame is short, provides less opportunity for computer-supported planning and analysis.

d. Conclusions

Significant negative relationships appeared between resources and user satisfaction, as well as resources and off-line usage. This indicates that IS investment by itself should not be considered as an IS success factor, in fact it actually seemed that increased resource allocation had a negative impact if it was not accompanied by a corresponding increase in IS sophistication. Overall findings seemed to justify a

contingency rather than a direct approach to the impact of the organizational context on computer-based information systems.

Raymond (1990) suggests that other factors that should be more thoroughly studied include the uncertainty of the extra-organizational environment, and other dimensions of organizational structure such as centralization and integration. Finally, IS implementation should be viewed as an organizational design activity that requires not only increased IS sophistication, but a corresponding increase in formalization, resources, and planning. IS implementors should make managers more aware of the greater explicitness of procedures and decision processes, the greater investment in both information and human resources, and of the planning process required to increase both IS sophistication and success.

V. IMPACT OF INFORMATION SYSTEMS ON ORGANIZATIONAL STRUCTURE

Information systems technology and its cost performance ratio opens up opportunities for radical changes in organizations and their processes. This has resulted in companies restructuring the way they perform work to decrease the cost of their primary business transactions. This takes the form of both process and function restructuring. Structural changes based on new forms of integration is often the key to enabling an organization to gain strategic advantage. Zuboff (1989) contends that IS enables companies to build their organization in ways previously unsupportable or unmanageable to best fit the problem, and then develop the technology to support that organizational structure. The real source of competitive advantage has become the ability of an organization to exploit information to learn and innovate more quickly than its competitors.

As seen earlier, even the management of the IS department itself is changing. It is no longer concerned with the managing a single IS function. The IS executive must manage a network of IS resources and support a variety of uses as determined by the steering committee or various concerned departments. As seen by the hybrid partnership model of IS development, managers must now become both people and technology managers.

A. THE ROLE OF IS IN ORGANIZATIONS

Information systems have assumed prominent positions in multiple roles in modern organizations. These roles include (Gurbaxani and Whang: 1991):

- Increasing scale efficiencies of operations by allowing mass production on an unprecedented scale. It has also introduced a high degree of flexibility in production and significantly reduced the cost of manufacturing a broad product line.
- Processing basic business transactions, decreasing middlemen (ie. reducing drug company sales staff by introducing scanner ordering in drugstores). This has introduced greater operational efficiency in market economies.
- Decision support, decision information costs are reduced by allowing decision makers cost-effective access to information and powerful tools (simulation and econometric modeling) for analyzing retrieved information. Improved decision quality increases operational efficiency.
- IS makes direct monitoring and performance evaluation less costly and gives management the ability to track performance at the level of individual transactions.
- Documentation and communication. Organization-wide networks and databases help to maintain corporate memory and reduce inconsistencies within the organization, contributing to lower internal coordination costs.

B. CHANGES AS A RESULT OF IT

1. Integrated Business Units (IBUs)

The integrating of various independent business units is becoming critical after many years of letting them develop their own IS systems independently. This is because the technologies are being found to be inconsistent, inhibiting organization-wide applications. This integration also enables a broader view of the company's goals and

objectives. IT has also enabled firms to take a global view of the marketplace, which was previously impossible (previously multinational in scope). The distinction is that multinational corporations develop products in each market for each market. Decision-making authority is typically localized by geographic area. The global approach uses common business procedures, products, and standards. This integration is occurring between entire industries as well as individual organizations, as exemplified by the unifying of auto rental firms, hotels, travel agents, and airlines to provide complete trip planning services.

The integration philosophy also applies to people, in that as firms downsize they will have a wider span of responsibility, leading to flatter organizations. Many believe what will result is an organization of interdisciplinary teams and multi-faceted individuals operating within a hierarchical context and within the wider context of the global market itself. Short (1990) states that "The measure of such a company's success will be how well it achieves a concurrence of effort between its functions, products, and geographic units. And how closely the results match the needs of the marketplace."

2. Informatting

Informatting is a term coined by Zuboff to describe the way in which IT has allowed workers to view processes, objects, and behaviors in a new transparent manner. For example, a temperature display of an internal process that was previously non-monitorable opens up a new window on the process. These new windows can allow companies to identify new opportunities or ways of operating.

3. Just-In Time Production

Information systems have provided for the efficient forecasting of future demands and production scheduling, as well as the efficient handling of material flows to the point of manufacture using on-line ordering systems. These capabilities can cut down on warehousing requirements and reduce production disruptions due to inventory shortfalls, achieving a significant reduction of inventory carrying costs. An additional benefit is that it for many industries it provides the flexibility to meet changing demands almost immediately.

4. Distributed Data Processing (DDP)

DDP is a system of user department and headquarters computers interconnected by a data communications network and integrated by a common database-oriented approach (O'Brien, 1988). The central headquarters computer maintains the corporate database, handles batch processing, supports headquarters operations, and controls the system communications function. This is not decentralized processing, since a decentralized system does not use a central processor and the remote sites cannot communicate with each other (O'Brien). With DDP, the small systems can perform many of their own processing tasks.

Local sites can maintain their own local database of information relevant to their section, generate their own reports, conduct local customer transactions, and enter/edit data for transmittal of summaries to the central site. The local site is

responsible for many of their own applications. They also receive updated data relative to their's and the corporate databases on a daily basis.

This IT structure helps to support procedures with critical response time requirements, shield critical data from tampering, and allows the use of less expensive computer systems (minicomputers and PCs vs. mainframes). Finally, this configuration makes the organization less susceptible to total system failure.

5. Advance Technology Groups

A new concept in organization is a business unit known as the advance technology group (ATG). Their function (Carlyle, 1988) is to serve as a watchdog and involves investigating and evaluating new technologies, influencing the development of the technology when feasible, and deciding when not to redesign the technology to suit your needs. The ATG serves to bring together the companies IS department and vendors in joint development ventures, allowing the organization to take a more active stance in technology creation, development, and management. It consists of more than just purchasing technology, the vendors also provide knowledge about technology development, and the organization helps provide the direction. This ATG/vendor partnership, along with the organization's chief technology officer, is rapidly becoming the decision-support vehicle for all major technological purchases by the organization (Carlyle).

Edward C. Johnson III (Fidelity Systems, Boston) created one of the earliest known ATGs, with a vision in his mind of a hybrid fusion of experts from business units, communications, and mainframe groups. The purpose was to create a neutral group with

no bent towards either mainframe or workstation technology bias. Also the group tends to be less biased towards particular consultants or vendors.

C. SUPPORTING STUDIES

1. Work Groups and Computer Support

This study (Eveland & Bikson, 1988) focuses on comparing two nearly identical work groups during their work on the same task of preparing reports on retirement planning issues. The only difference between the groups was that one of the groups were given an E-mail capability. The focus of observation was on communications traffic and four interviews conducted during the course of the experiment.

The findings show that the technology did make a difference. While both groups broke themselves into six subcommittees, nobody in the standard group belonged to more than one subcommittee, while most of those in the E-mail group were involved in two or more. Also, the average size of these subgroups for the Electronic work group was 10+ people, while the standard group's subcommittees consisted of six to seven members. Another difference revealed by the interviews was that members of the electronic group became increasingly more positive about task involvement as well as subgroup and task force effectiveness. In measuring the general satisfaction with the overall

accomplishments of their task force, the electronic group showed increases, while the standard group showed stagnation or even decline.

The researchers believe that this experiment demonstrates that an electronic network can provide an effective infrastructure for sustained collaborative activities, even among people that are not computer sophisticated initially. The system played a significant role in the administration and coordination of task force activities, and also contributed heavily to the shared development, review, and dissemination of the group's work. The electronic network structure also seemed to allow groups to restructure more easily, with the electronic group forming new and different subgroups as subtasks at hand required. Also, it was believed that the E-mail helped to form new social ties and maintain old ones, extending the useful life of the lateral relations created. Experimenters feel the following conclusions were corroborated:

- The electronic group developed a structure much different than the standard group. While maintaining its formal organization, it also supported a set of alternative structures not present in the standard group.

- Electronic group allowed different people to work at different times according to their own schedules and significantly increased the ability of non-collocated retired members to actively participate.

- Electronic group had a significantly higher degree of contact and less communication isolation. It was generally less centralized both overall and in its task group interactions.

- Electronic group maintained higher levels of communications in general through all channels.

- The "humanware" demands of the electronic system could not be discounted, since employees generally lacked the opportunity to acquire the level of knowledge in this technology that many of the retirees developed; accordingly, it was the retirees in the task force that controlled work group production processes. To compare their

final products, the standard groups product was about 15 pages, while the electronic group's was about 75 pages in length. The content of the reports were also different in their approach to the solution, suggesting that work tools really do condition how groups define their work goals.

2. Telecommuting

An open-ended survey conducted by Risman and Tomaskovic-Devey (1989) of the personnel directors in the 100 largest firms headquartered in North Carolina was conducted to determine the proliferation of the telecommuting strategy. Telecommuting can both reduce company labor costs and provide schedule flexibility for employees. Actual usage of this strategy was very low (only 15 firms currently used it, and to a very limited extent).

The most commonly perceived managerial benefits of telecommuting were increased productivity, increased employee satisfaction, and decreased labor costs. Over 76 percent of the respondents expressed the belief that loss of managerial control would be a potential problem.

Although great potential exists for telecommuting, little reorganization has occurred. This tends to support Olson's contention that management philosophy, rather than technology itself will predict organizational change. Risman and Tomaskovic-Devey (1989) support the previously mentioned beliefs that the adoption of innovations depend on the organizational system into which it is introduced, as well as the ability of an employee to accept or resist change will affect the eventual adoption of any technology.

3. Power Versus Change

Burkhardt and Brass (1990) conducted a longitudinal study to examine the effects of technology on organizational structure and power. Structural arrangements act as conduits of technological change and thus may influence the organizational technology as well as be influenced by it. Those in power seek to maintain or solidify their power by reinforcing the existing organizational structure (Pfeffer, 1981). Because new technology introduces crucial uncertainties, it represents an opportunity for employees to gain influence. Those who are able to reduce uncertainty for themselves and others can increase their power. The result may be a redistribution of power within the organization.

The study involved the introduction and development of a computer system with distributed processing capabilities available to all employees. Four questionnaires were used at different points in time to track the introduction and diffusion of the system. The computing was previously done externally, and it significantly changed the way they analyzed data and prepared documents for publication, so the introduction of the computer's capabilities can be regarded as a major change in the organization's technology.

The study explored possible changes in the social network structure and individual influence brought about by the introduction and diffusion of new technology in an organization. The authors predicted that stability or change is contingent on the social network position and power of early adopters of the new technology since a change in the structure may necessitate a change in the distribution of power and vice-versa.

Burkhardt and Brass (1990) found that despite the forces supporting stability, considerable change in both structure and power occurred following the technological change within the organization. Being central and powerful prior to the introduction of the new technology was not related to early adoption. Rather, early adoption was a function of individual characteristics relevant to the change process, such as attitude toward computer technology and degree of integration into the system. This supports earlier claims (Rogers, 1971) that innovation was counter to system norms in that persons not well integrated into the system tended to be early adopters.

Those employees who were powerful, central figures in the organization prior to the change were not totally displaced by early adopters. Although the early adopters gained substantially more influence, those with prior power maintained much of their power, resulting in an overall increase in the total amount of individual influence in the organization and the network becoming more interconnected.

4. Economic Resource Structuring and IS

Penrose (1959) first proposed firms be viewed as collections of resources and the growth of firms is driven by the desire to use slack resources. An economic structure can be viewed as the distribution of resources to activities and the interactions among these activities. Two types of interactions are recognized: vertical interactions, which considers the flow of goods and services along a value chain; and horizontal interactions which considers the coordination of similar or complimentary resources among multiple markets or industries.

Organizational restructuring is driven by the revaluation of resources. IS can have a role in this restructuring in two ways (Clemons and Rowe, 1989). First, innovations in IS or innovative applications of IS can be a source of this resource revaluation. The application itself is a strategic resource or the IS directly influences the economics of production or transaction activities. Second, IS can act as a mechanism for implementing strategies for adjusting to changing values of other, non-IS resources.

Organizations can be economically restructured based on the three ways that firms can alter or redeploy their economic resources (Clemons and Rowe, 1989). Firms can expand or contract in **size** within a market relative to the total size of the market. They can **diversify** by moving into, or out of different markets and industries. These are both examples of horizontal integration. Finally, a firm can **integrate vertically** by expanding into, or withdrawing from, activities that are vertically related within a single value chain.

Horizontal integration of resources within a market is primarily driven by the desire for scale economies. IS serves to increase scale economies as both a resource itself and a mechanism for coordinating other resources, thus creating a pressure to increase concentration in most markets. Horizontal integration of a similar resource between markets can be done to reduce average unit costs. This diversification also creates scope economies, where the value of integration is greater than the value of the parts independently (synergy).

Vertical integration of resources is driven by the balancing of production economies and transaction costs. An example of this is desktop publishing and other graphic services that are increasingly being brought in-house. This occurs because there is a decrease in the production economies of scale relative to the transaction costs involved. Information systems can also lead to a vertical disintegration, or outsourcing, of a strategic resource to another firm when a firm is at a scale disadvantage in operating those resources and it is cost prohibitive to obtain the resources necessary to compete.

5. Agency and Transaction Cost Theories

Gurbaxani and Whang (1991) proposed an economic model that addresses how IS affects some key measures of organizational structure. It considers both the agency theory and the transaction cost theory.

Agency costs are costs incurred as a result of discrepancies between the objectives of the organization and those of its employees or agents. Decision information costs increase as the decision authority is moved up in the hierarchy, away from where the information is most easily available. There is a tradeoff between the cost of making a poor decision and not making a timely decision. Gurbaxani and Whang (1991) argue that as decision making rights are pushed downward in an organization, the costs of communicating information decrease while agency costs resulting from goal divergence increase. Therefore, the decision rights should reside where the sum of these costs is minimized. This theory provides an understanding of internal coordination costs.

The transaction cost theory considers external coordination, or market transaction, costs. There are two basic types of transaction costs, that associated with establishing and maintaining contractual relationships with outside parties, and another due to the loss of operational efficiencies. IS can directly reduce the latter case by providing a cost-effective means to access market information and process transactions (Gurbaxani and Whang, 1991).

The model of a firm (Gurbaxani and Whang) incorporates three cost components: internal coordination costs, external coordination costs, and production and marketing costs. Firm size is determined to minimize the sum of these costs.

IS can improve the quality and speed of upper management's decision-making processes. This phenomenon may lead decision rights to move upwards in the organizational hierarchy, leading to more centralized management. Examples include centralized hotel reservation systems and the Otis Elevator Company, a firm which centralized its maintenance scheduling function. Firms may also centralize some decision rights while decentralizing others, leading to a hybrid structure.

Gurbaxani and Whang (1991) contend that IS can reduce external coordination costs, leading organizations to turn to markets rather than integrate vertically with suppliers (i.e., the reservation system for airlines has mostly been delegated to travel agencies). IS can also reduce internal coordination costs, so cost effective IS can result in both a vertically and horizontally larger firm. Their research (Gurbaxani and Whang, 1991) shows that the locating of decision-making authority is not definitive, and depends

on other organizational and environmental factors such as the role of IS in the firm, characteristics of the information flows, and organizational culture.

VI: CONCLUSIONS

Early predictions that IS would cause a centralization trend (Leavit and Whisler, 1958; Whisler, 1967; Withington, 1971) have been shown to be simplistic. IS supports a range of organization structures across a centralization-decentralization spectrum. The concern in determining how to employ an IS should be how it could best serve the organizational objectives. Each organization should consider the best degree of centralization for its own company. The IS function has three aspects that should each be considered for the best degree of centralization (Reinbach and Tasso, 1968); systems management, systems operations, and systems development.

IS has the potential to help, or hinder an organization. Several characteristics must be considered to successfully implement a system. First to be considered is the value added by the process or function that is being automated. If the process is no longer necessary or valuable to the organization, what good is it to automate a useless process? Ideally, the processes should match the objectives of the corporation, and eventually, according to Nolan (1979), the automated data processing functions should mirror the information flows through the organization.

Zuboff (1989) suggests that a firm should first consider reorganizing to an optimal form, and then building an IS to support that structure. If reorganization is too great a task, or unnecessary, the IS selected should be chosen to match the organizational structure and be capable of handling **future** data processing needs. If the system does not

complement the organizational structure, its success may be diminished because it does not adequately support operations. More importantly, organizational characteristics, such as degree of formalization and standardization, influence which **type** of IS would work most effectively in an organization.

Literature has shown that certain organizational characteristics can affect the **success** of IS implementation, such as the time frame for implementation, degree of top level executive support, and resource availability for project development.

One of the greatest inhibitors to IS implementation seems to be the human element. This can either be in the form of lack of user acceptance, or in the case of telecommuting, the perception of management of a loss of control over their employees. The success of the IS is reduced if the IS works against existing power structures (Burkhardt and Brass, 1990), since workers with power will be reluctant to accept a system that reduces their power.

Recent research has considered many facets of both organizational structure as well as IS structure in the implementation of a system. If there is an area that may need more research, it would be an investigation of how great an affect user resistance would have on IS success. How great would the effect of user resistance be on the effectiveness of a mandated system? User acceptance may prove to be a larger factor than many researchers consider it to be.

Such a critical task as IS selection can not be adequately performed by a single person, which explains the growing popularity of ATGs and steering committees. To provide validity to the IS planners, their position in the organization should be high (MIS

chief executive not more than two levels in the hierarchy below the CEO of the organization (Ein-Dor and Segev, 1981)), indicating corporate recognition of the importance of IS. This also positions the planners in a location in the organization to see the overall strategies of the company, and thus how IS can best support them. Since many of today's organizations have departments that each follow different organizational strategies (i.e. adhocracy, bureaucracy, etc.), planners must be aware that no one IS may be appropriate for the entire organization. There may be several different IS schemes effectively operating in a single organization.

Information systems are affecting the structure of jobs in organizations. This change can be manifested in two ways; the enlargement of jobs by combining several tasks into one through horizontal and vertical integration, with employees becoming necessarily more intelligent, or job simplification with the intelligence or skill levels required of the employees being reduced.

The IS environment is a dynamic one, with the cost benefit ratio being large enough to justify implementing improved systems every couple years. Information systems are a source of change for the economic values of organizational resources. This being the case, organizations must periodically review what projects their IS funds are being spent on, and reevaluate where their investments could best be applied.

There are no absolutes when considering IS systems and organizational structures, but a better, and hence more effective, match can be made when attention is given to finding a system that supports company structure and operations. The far-sighted company also considers the new business strategies or organizational design possibilities that computer

technology may provide. These include some of the concepts mentioned in this paper, such as Just-In-Time production, distributed processing, and integrated business units.

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